

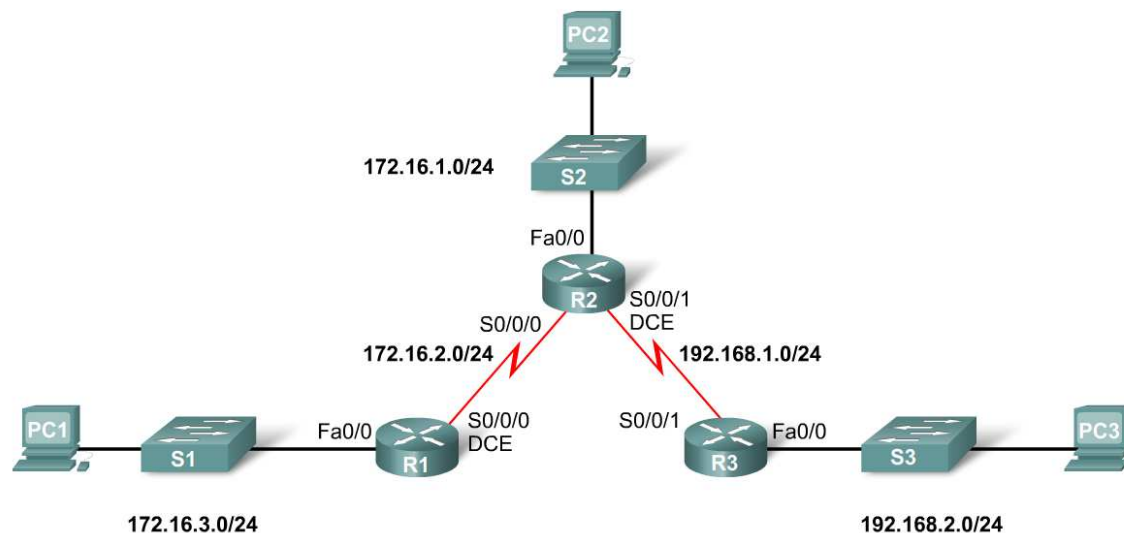
# Static Routing

Routing Protocols and Concepts –  
Ola Lundh



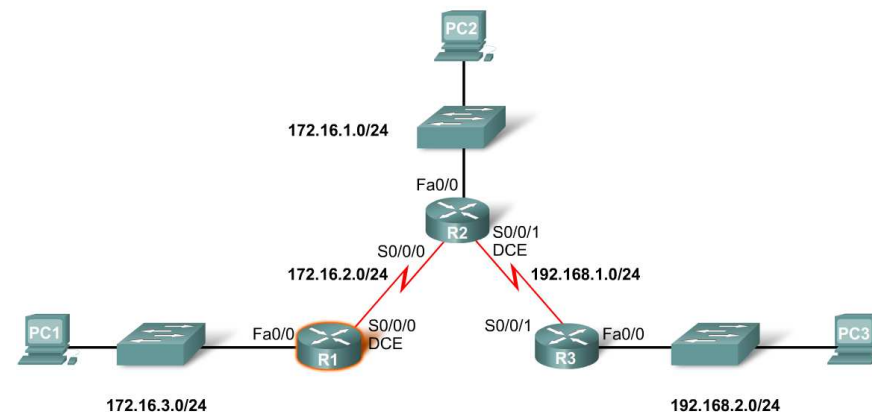
# General Role of the Router

- Functions of a Router
  - Best Path Selections
  - Forwarding packets to destination
- Introducing the Topology
  - 3 routers connected via WAN links
  - Each router connected to a LAN represented by a switch and a PC



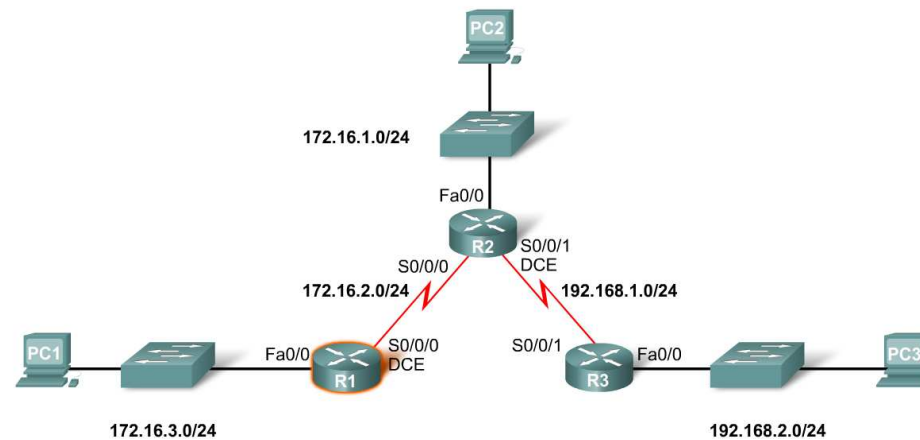
# Interfaces

- **Examining Router Interfaces**
  - -Show IP router command – used to view routing table
  - -Show Interfaces command – used to show status of an interface
  - -Show IP Interface brief command – used to show a portion of the interface information
  - -Show running-config command – used to show configuration file in RAM



# Interfaces

- **Configuring an Ethernet interface**
  - By default all serial and Ethernet interfaces are down
  - To enable an interface use the No Shutdown command



```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route
```

Gateway of last resort is not set

R1#



# Interfaces

- **Verifying Ethernet interface**
  - Show interfaces for fastEthernet 0/0 – command used to show status of fast Ethernet port
  - Show ip interface brief
  - Show running-config
- Ethernet interfaces participate in ARP

## Verifying MAC Addresses on Ethernet Interfaces

```
R1#show interfaces fastethernet 0/0
FastEthernet0/0 is up, line protocol is up
  Hardware is AmdFE, address is 000c.3010.9260 (bia 000c.3010.9260)
  Internet address is 172.16.3.1/24
  <output omitted>
R1#
```

Ethernet interfaces have MAC addresses.



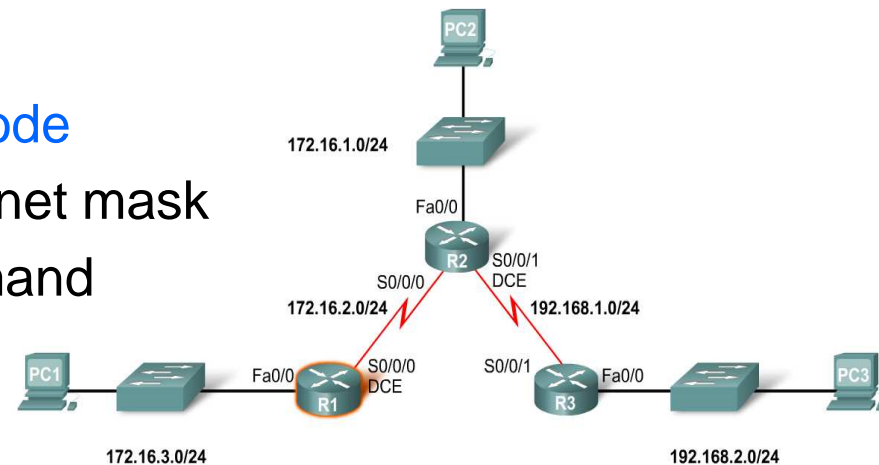
# Interfaces

- **Configuring a Serial interface**

- Enter **interface configuration mode**
- Enter in the ip address and subnet mask
- Enter in the **no shutdown** command

- **Example:**

- R1(config)#interface serial 0/0
- R1(config-if)#ip address 172.16.2.1 255.255.255.0
- R1(config-if)#no shutdown



Serial interface with down and down

```
R1#show interfaces serial 0/0/0
Serial0/0/0 is administratively down, line protocol is down
Hardware is PowerQUICC Serial
Internet address is 172.16.2.1/24
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
<output omitted>
```

Serial interface is down and down even though it has an IP address and was enabled with no shutdown command.

# Interfaces

- **Examining Router Interfaces**
  - Physically connecting a WAN Interface.
  - A WAN Physical Layer connection has sides:
    - Data Circuit-terminating Equipment (DCE) – This is the service provider. CSU/DSU is a DCE device.
    - Data Terminal Equipment (DTE) – Typically the router is the DTE device.



# Interfaces

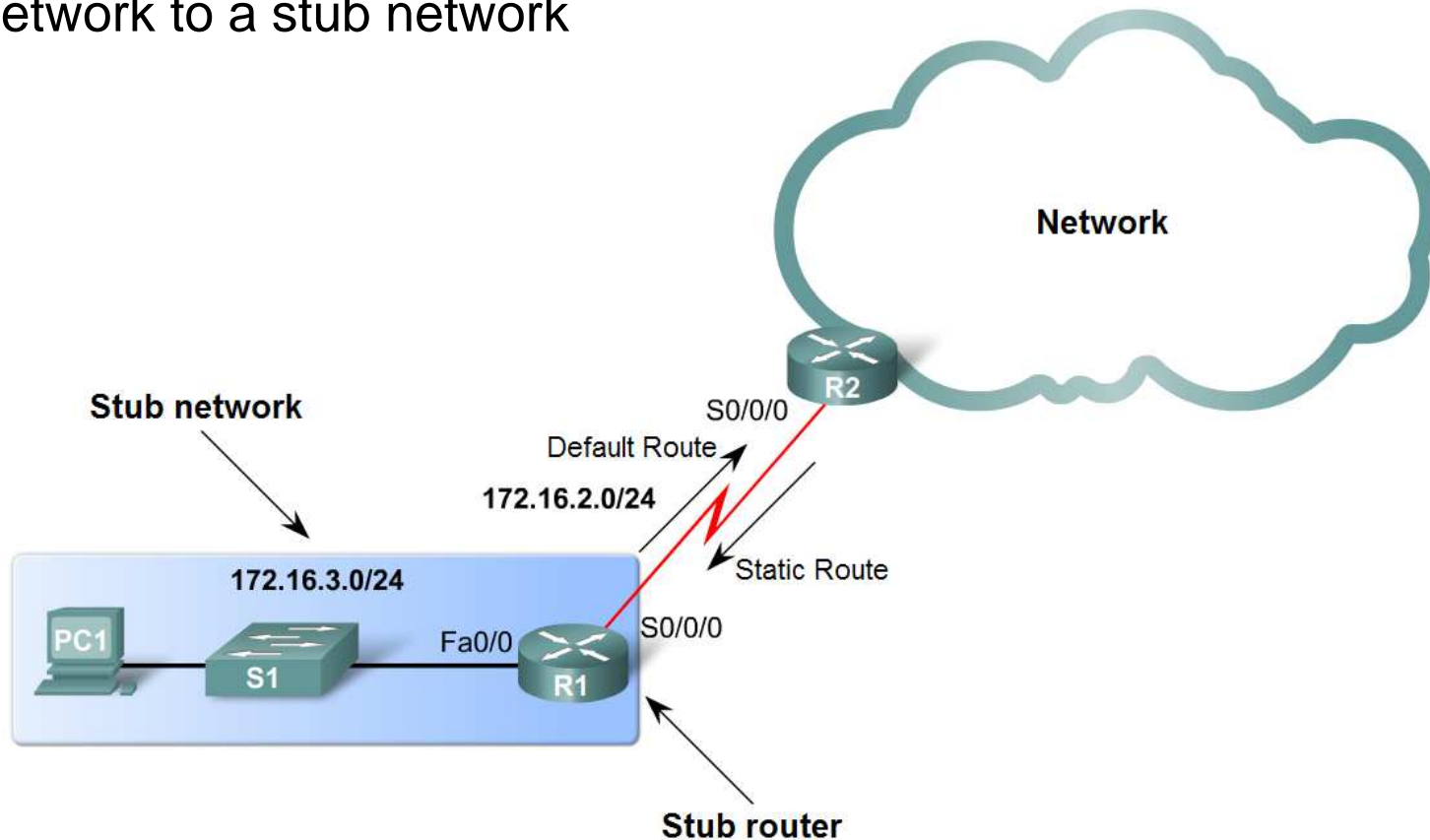
- **Configuring serial links in a lab environment**
  - One side of a serial connection must be considered a DCE
  - This requires placing a clocking signal – use the clock rate command.
  - Example:
    - R1(config)#interface serial 0/0
    - R1(config-if)#clockrate 64000
  - Serial Interfaces require a clock signal to control the timing of the communications.





# Static Routes with Exit Interfaces

- **Purpose of a static route**
  - A manually configured route used when routing from a network to a stub network



# Static Routes with Exit Interfaces

- **IP route command**
  - To configure a static route use the following command: **ip route**
  - Example:
    - Router(config)# ip route network-address subnet-mask {ip-address | exit-interface }

```
Router(config)# ip route network-address subnet-mask  
{ip-address | exit-interface }
```

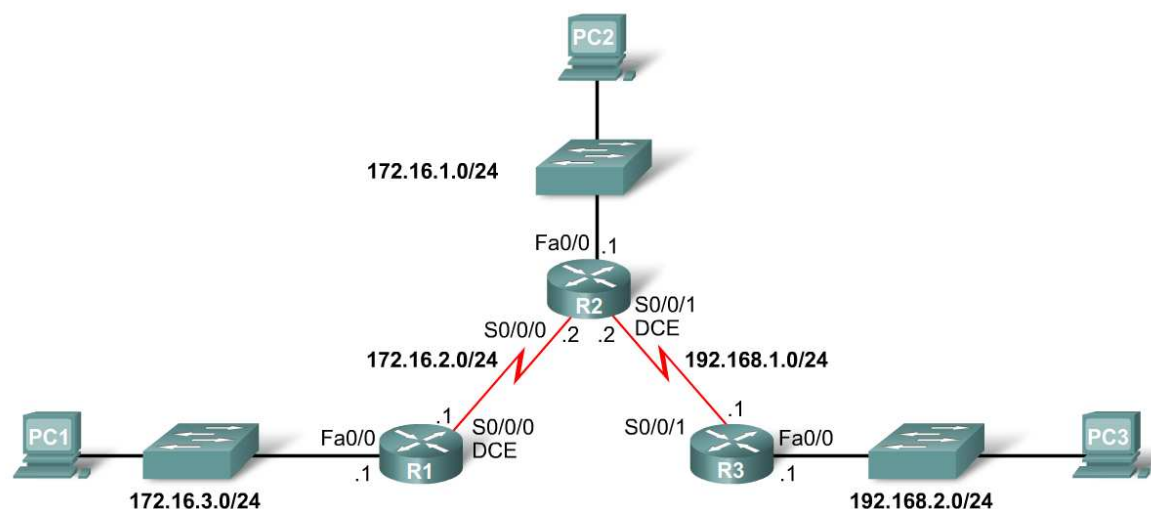
Parameter	Description
<b>network-address</b>	Destination network address of the remote network to be added to the routing table.
<b>subnet-mask</b>	Subnet mask of the remote network to be added to the routing table. The subnet mask can be modified to summarize a group of networks.
<b>ip-address</b>	Commonly referred to as the next-hop router's IP address.
<b>exit-interface</b>	Outgoing interface that is used to forward packets to the destination network.



# Static Routes with Exit Interfaces

- **Dissecting static route syntax**
  - ip route - Static route command
  - 172.16.1.0 – Destination network address
  - 255.255.255.0 - Subnet mask of destination network
  - 172.16.2.2 - Serial 0/0/0 interface IP address on R2, which is the "next-hop" to this network

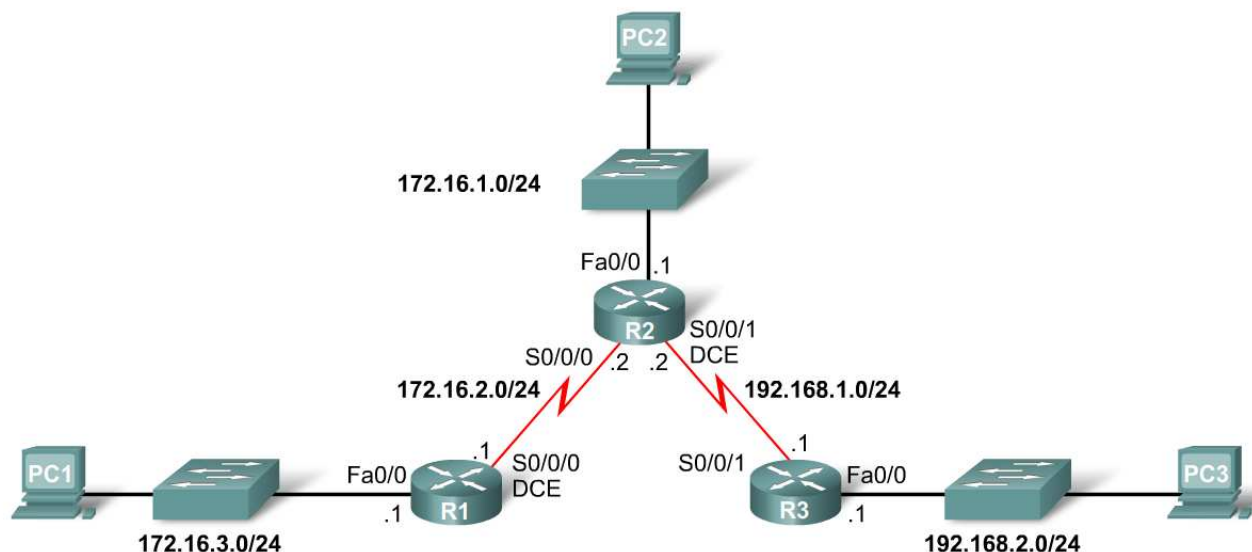
**R1 static route to R2's LAN**



# Static Routes with Exit Interfaces

- **Configuring routes to 2 or more remote networks**
  - Use the following commands for R1
    - R1(config)#ip route 192.168.1.0 255.255.255.0 172.16.2.2
    - R1(config)#ip route 192.168.2.0 255.255.255.0 172.16.2.2

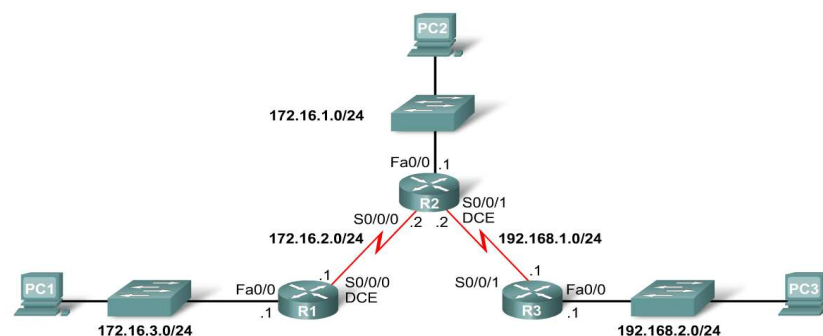
**R1 static route to R2's LAN**



# Static Routes with Exit Interfaces

- Resolving to an Exit Interface
  - **Recursive route lookup** - Occurs when the router has to perform multiple lookups in the routing table before forwarding a packet. A static route that forwards all packets to the next-hop IP address goes through the following process (recursive route lookup)
    - The router first must match static route's destination IP address with the Next hop address
    - The next hop address is then matched to an exit interface

R1 does a recursive lookup



# Static Routes with Exit Interfaces

- Configuring a Static route with an Exit Interface
  - Static routes configured with an exit interface are more efficient
  - The routing table can resolve the exit interface in a single search instead of 2 searches
  - Example of syntax require to configure a static route with an exit interface

## R1 routes depend on exit interface

```
R1#debug ip routing
IP routing debugging is on
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int s0/0/0
R1(config-if)#shutdown
R1(config-if)#end

is_up: 0 state: 6 sub state: 1 line: 0
RT: interface Serial0/0/0 removed from routing table
RT: del 172.16.2.0/24 via 0.0.0.0, connected metric [0/0]
RT: delete subnet route to 172.16.2.0/24
RT: del 192.168.1.0 via 172.16.2.2, static metric [1/0]
RT: delete network route to 192.168.1.0
RT: del 172.16.1.0/24 via 172.16.2.2, static metric [1/0]
RT: delete subnet route to 172.16.1.0/24

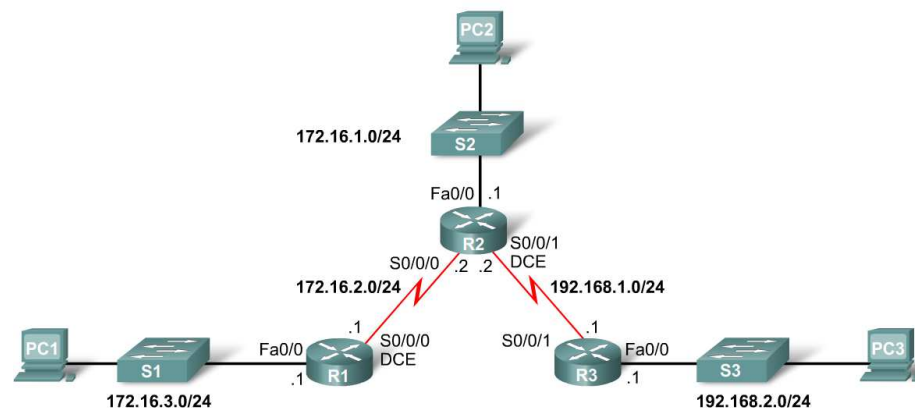
R1#show ip route
<output omitted>
```

Four routes are removed.  
Only one route is left in the table.



# Static Routes with Exit Interfaces

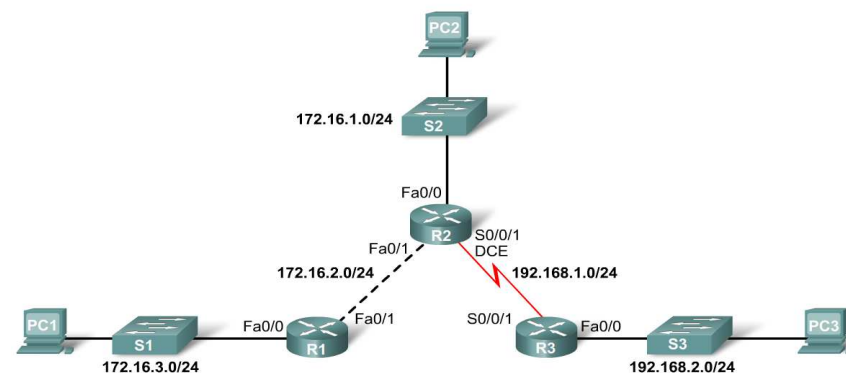
- **Verifying the Static Route Configuration**
  - Use the following commands
    - Step 1 `show running-config`
    - Step 2 `verify` static route has been entered correctly
    - Step 3 `show ip route`
    - Step 4 `verify` route was configured in routing table
    - Step 5 issue `ping` command to `verify` packets can reach destination and that Return path is working



# Static Routes with Exit Interfaces

- **Ethernet interfaces and ARP.**
  - **If a static route is configured on an Ethernet link**
    - If the packet is sent to the next-hop router then...
      - the **destination MAC address will be** the address of the **next hop's Ethernet interface**
    - This is found by the router consulting the ARP table.
    - If an entry isn't found then an ARP request will be sent out

Exit interface and next-hop address





# Summary and Default Route

- **Summarizing routes** reduces the size of the routing table.
- **Route summarization** is the process of combining a number of static routes into a single static route.



# Summary and Default Route

- **Configuring a summary route**
  - Step 1: Delete the current static route
  - Step 2: Configure the summary static route
  - Step 3: Verify the new static route

```
R3#show ip route
<output omitted>

Gateway of last resort is not set

172.16.0.0/24 is subnetted, 3 subnets
S   172.16.1.0 is directly connected, Serial0/0/1
S   172.16.2.0 is directly connected, Serial0/0/1
S   172.16.3.0 is directly connected, Serial0/0/1
C   192.168.1.0/24 is directly connected, Serial0/0/1
C   192.168.2.0/24 is directly connected, FastEthernet0/0
```

```
R3#show ip route
<output omitted>

Gateway of last resort is not set

172.16.0.0/22 is subnetted, 1 subnets
S   172.16.0.0 is directly connected, Serial0/0/1
C   192.168.1.0/24 is directly connected, Serial0/1
C   192.168.2.0/24 is directly connected, FastEthernet0/0
```

```
R3#ping 172.16.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/29/32 ms
R3#ping 172.16.2.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.2.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms
R3#ping 172.16.3.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/56/60 ms
R3#
```



# Summary and Default Route

- **Default Static Route**
  - This is a route that will match all packets. Stub routers that have a number of static routes all exiting the same interface are good candidates for a default route.
    - -Like route summarization this will help reduce the size of the routing table
- **Configuring a default static route**
  - Similar to configuring a static route. Except that destination IP address and subnet mask are all zeros
  - Example:
    - -Router(config)#ip route 0.0.0.0 0.0.0.0 [exit-interface | ip-address ]



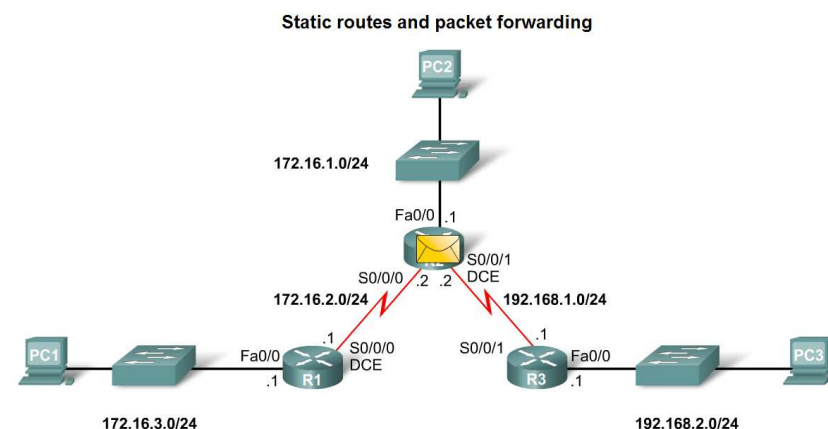
# Summary and Default Route

- **Static routes and subnet masks**
  - The routing table lookup process will **use the most specific match** when comparing destination IP address and subnet mask
- **Default static routes and subnet masks**
  - Since the subnet mask used on a default static route is 0.0.0.0 all packets will match.



# Static Routes and Packet Forwarding

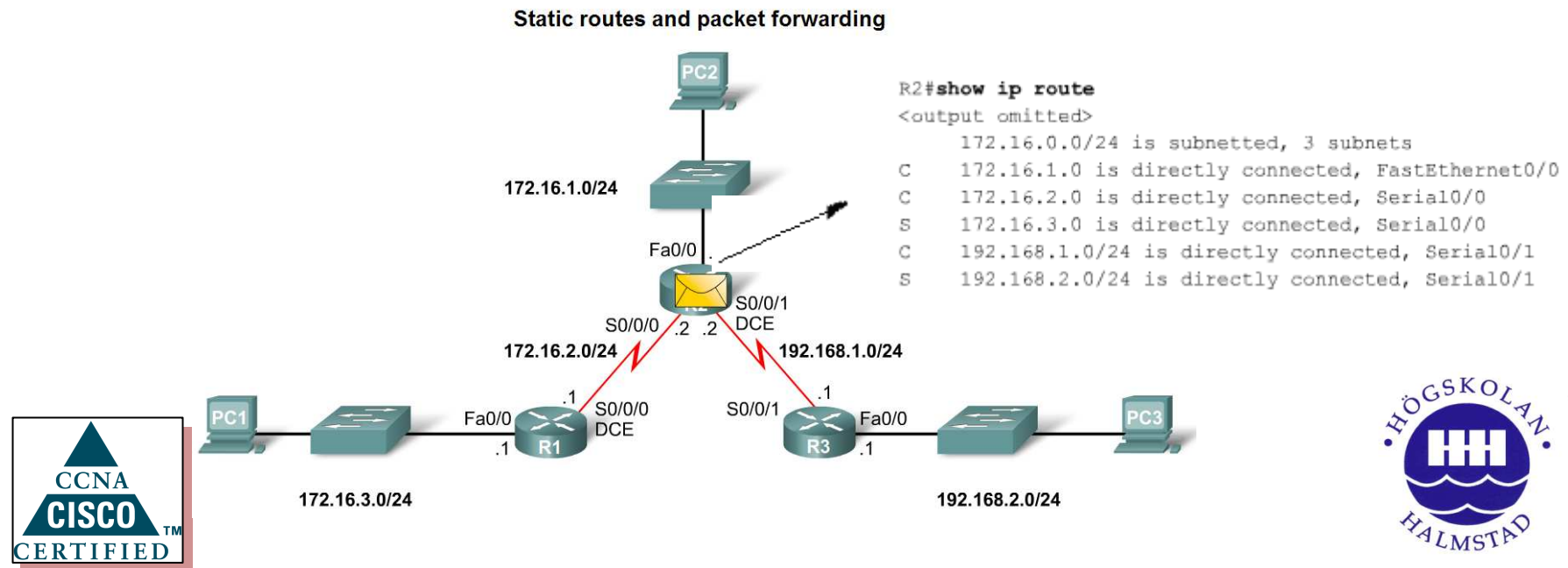
- Packet forwarding with static routes.
- Router 1
  - Packet arrives on R1's FastEthernet 0/0 interface
  - R1 does not have a route to the destination network, 192.168.2.0/24
  - R1 uses the default static route.



```
R1#show ip route
<output omitted>
    172.16.0.0/24 is subnetted, 2 subnets
C   172.16.2.0 is directly connected, Serial0/0
C   172.16.3.0 is directly connected, FastEthernet0/0
S*  0.0.0.0/0 is directly connected, Serial0/0
```

# Static Routes and Packet Forwarding

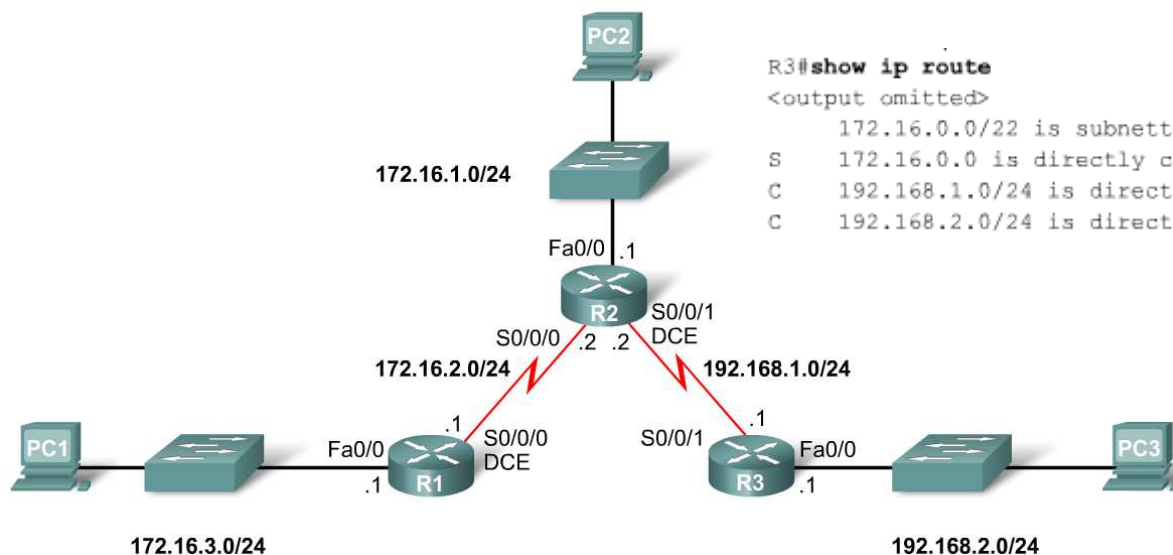
- Packet forwarding with static routes.
- Router 2
  - The packet arrives on the Serial 0/0/0 interface on R2.
  - R2 has a static route to 192.168.2.0/24 out Serial0/0/1.



# Static Routes and Packet Forwarding

- Packet forwarding with static routes.
- Router 3
  - The packet arrives on the Serial0/0/1 interface on R3.
  - R3 has a connected route to 192.168.2.0/24 out FastEthernet 0/1.

Static routes and packet forwarding



```
R3#show ip route
<output omitted>
 172.16.0.0/22 is subnetted, 1 subnets
 S   172.16.0.0 is directly connected, Serial0/1
 C   192.168.1.0/24 is directly connected, Serial0/1
 C   192.168.2.0/24 is directly connected, FastEthernet0/0
```



# Static Routes and Packet Forwarding

- Troubleshooting a Missing Route
- Tools that can be used to isolate routing problems include:
  - **Ping**– tests end to end connectivity
  - **Traceroute**– used to discover all of the hops (routers) along the path between 2 points
  - **Show IP route**– used to display routing table & ascertain forwarding process
  - **Show ip interface brief**- used to show status of router interfaces





# Summary

- **Routers**
  - Operate at layer 3
  - Functions include best path selection & forwarding packets
- **Connecting Networks**
  - **WANs**
    - Serial cables are connected to router serial ports.
    - In the lab environment clock rates must be configured for DCE
  - **LANs**
    - Straight through cables or cross over cables are used to connect to fastethernet port. (The type of cable used depends on what devices are being connected)



# Summary

- **Static Routes**
  - -This is a manually configured path that specifies how the router will get to a certain point using a certain path.
- **Summary static routes**
  - -This is several static routes that have been condensed into a single static route.
- **Default route**
  - -It is the route packets use if there is no other possible match for their destination in the routing table.
- **Troubleshooting static routes** may require some of the following commands:
  - -Ping
  - -Traceroute
  - -Show IP route
  - -Show ip interface brief
  - -Show cdp neighbors detail

